the belt and the element over the change in the slipping velocity (V), i.e. the μ-V characteristic, is in a negative gradient. Conventional automatic transmission fluids did not always exhibit excellent μ-V characteristics in belt-type CVTs, particularly when they were used for long periods of time. Accordingly, the change in the μ-V characteristic became larger and the scratch noises occurred more frequently.

Applicant has discovered that these problems may be solved by adjusting the mass ratios of specific elements, such as phosphorus, calcium, boron, and sulfur, which are contained in a lubricating oil composition, as well as by maintaining specific concentrations of phosphorus, sulfur derived from a base oil, and sulfur derived from sulfur-based additives. In preferred embodiments, specific sulfur-based additives are included in the lubricating oil composition.

The advantages of the presently claimed composition are shown in Tables 1 to 4 of the present application. Specifically, it can be seen that the inventive compositions prepared in Examples 1 to 6 exhibited positive gradient μ-V characteristics, whereas all of the compositions described in Comparative Examples 1 to 7 exhibited negative gradient μ-V characteristics. Further, comparing Example 1 with Comparative Examples 6 and 7 in Table 4, the claimed composition maintained good positive gradient μ-V characteristics even after it had been deteriorated by oxidation, thus corresponding to an oil which had been used for a long period of time.

Rejection Under § 103(a) Based on Sato

Regarding claims 1-4, the Examiner argues that Sato teaches a lubricating oil composition for continuously variable transmissions which comprises a lubricating base oil (mineral oil and/or synthetic oil) formulated with: (A) a wear preventative, (B) a metal detergent, and (C) an ashless dispersant. The wear preventative is allegedly a phosphorus-based additive present in an amount to provide a range of 200-500 ppm (0.02 to 0.05 wt%) as phosphorus based on the total weight of the composition. The Examiner argues that the metal detergent may be a calcium salt to provide a range of 100-1000 ppm (0.01 to 0.1 wt%) as metal content, and that the ashless dispersant may be a borated succinimide with a boron content of 0.1 to 5 wt %. The Examiner notes that Sato allows for the addition of other additive components to the

composition, including benzotriazole and thiadiazole metal deactivators in amounts of 0.001 to 3 wt%. Finally, the Examiner takes the position that although the mass ratios of phosphorus:calcium:boron:sulfur are not specifically set forth in Sato, the amounts set forth in compounds containing these elements would result in lubricant compositions which meet the claimed ratios. Applicant respectfully traverses this rejection as follows.

Sato discloses a lubricating oil composition for CVTs which contains an ashless dispersant consisting of a succininmide having boron at a rate of one or more atoms per molecule of the ashless dispersant. The Sato composition is taught to provide a high friction coefficient and to maintain enhanced oxidation stability for a long period of time. However, the invention of Sato is not designed to provide excellent μ-V characteristics so as to always be maintained in a positive gradient in belt type CVTs to prevent the occurrence of scratch noises even after being used for a long period or time. Since Sato does not acknowledge the need to maintain excellent μ-V characteristics or a positive gradient thereof, there would have been no motivation to adjust the parameters (such as sulfur content) which are necessary to obtain such results.

Sato does not teach or suggest the claimed mass ratio of sulfur to phosphorus, the claimed sulfur content derived from a base oil, or the claimed concentration of sulfur derived from sulfur-based additives. The Examiner argues that these values are inherently taught by Sato since the amounts of the compounds containing these elements would necessarily result in the claimed amounts. To the contrary, concerning sulfur content, for example, as seen in Table 1 of the specification, Examples 1-4 containing a solvent-refined paraffin mineral oil have a base oil kinematic viscosity of 4.1 mm^2/s at 100°C, and the concentration of sulfur derived from the base oil is <u>0 mass %</u>. The composition of Comparative Example 6 (Table 4) also contains a base oil having a kinematic viscosity of 4.1 mm^2/s at 100° C but a sulfur content of <u>0.15 mass %</u>, outside of the claimed range. While the composition of Comparative Example 6 exhibited a positive gradient in μ-V characteristics when a new oil was used, a negative gradient was observed after ISOT (when the deteriorated oil was used). Therefore, the amount of sulfur in the composition which is derived from the base oil is critical for providing the observed favorable μ-V characteristics after oxidation. Since Sato does not specifically teach the mass % of sulfur, there

would have been no suggestion or motivation based on Sato that such a concentration would have been limited to not more than 0.1 mass % as claimed.

In fact, if the composition of Sato were to contain 0.001 to 3 wt% thiadiazole ($C_{10}H_7N_3S$), as taught by Sato at col. 6, lines 39-44, the composition would contain 1.6×10^{-6} to 0.005 wt% sulfur. Such a concentration does not fall within the claimed range of 0.01 to 0.15 percent by mass of sulfur derived from a sulfur-based additive. Further, as noted above, there would have been no motivation based on Sato to adjust the sulfur concentration to fall within the claimed range.

Claim 8 recites a specific class of thiadiazole. Since Sato only teaches that "thiadiazoles and derivatives thereof" (col. 6, lines 39-40) may be included, there is no teaching or suggestion in Sato of including the specific claimed thiadiazole compounds.

Finally, claims 7 and 9 recite a Ca/P mass ratio of 0.1 to 1 and a B/P mass ratio of 0.06 to 0.8. In all of the examples of Sato, the Ca/P ratio is 500/350, or 1.4, which is outside the claimed range. Further, in Examples 1 and 2 of Sato, the B/P ratios are 1.4 and 1.0, respectively, which are outside the claimed range. (In Example 1, Sato teaches 7 atoms of boron/molecule; 7.1 x 11 (atomic weight of boron)/1600 x 100 = 4.9%. Therefore, the boron content is 4.9 x 1.0/100 = 490 ppm, and the B/P ratio is 490/350 = 1.4.)

For all of these reasons, Sato does not teach or suggest all of the claimed elements, nor would the results exhibited by the presently claimed invention have been expected based on Sato. Accordingly, reconsideration and withdrawal of the § 103(a) rejection based on Sato are respectfully requested.

Rejection Under § 103(a) Based on Watts in view of Smalheer

The Examiner argues that Watts teaches lubricating oil compositions for use in automatic transmissions which contain a major amount of lubricating oil and minor amounts of: (A) a phosphoric acid-containing compound, and (B) an ashless antioxidant. Watts allegedly teaches that the preferred range of component (A) corresponds to approximately 0.02 to 0.04 mass percent phosphorus in the oil, and also that a source of boron is desirably present in the oil

composition, which may be in the form of borated dispersants, borated amines, borated alcohols, borated esters, or alkyl borates. The Examiner contends that Watts also allows for the addition of other additives to the oil compositions, including corrosion inhibitors and detergents, which the Examiner argues are typically disclosed in Smalheer. Suitable corrosion inhibitors allegedly include metal dithiophosphates and metal dithiocarbamates, and suitable detergents include calcium-containing detergents. The Examiner argues that Watts teaches amounts of the various additives in the Table at col. 3, and concludes that the transmission compositions of Watts meet the claimed limitations. Finally, the Examiner takes the position that although the mass ratios of phosphorus:calcium:boron:sulfur are not specifically set forth in Watts, the amounts set forth in compounds containing these elements would result in lubricant compositions which meet the claimed ratio. Applicant respectfully traverses this rejection as follows.

Watts teaches a lubricating oil composition comprising a major amount of a lubricating oil and minor amounts of: (A) phosphoric acid and (B) di-nonyl-diphenylamine, which are taught to improve the oxidation stability of the composition. However, the invention of Watts is not designed to provide excellent μ-V characteristics so as to always be maintained in a positive gradient in belt type CVTs to prevent the occurrence of scratch noises even after being used for a long period or time. Since Watts does not acknowledge the need to maintain excellent μ-V characteristics or a positive gradient thereof, there would have been no motivation to adjust the parameters (such as sulfur content) which are necessary to obtain such results.

Further, Watts does not teach or suggest the claimed concentrations of sulfur derived from a base oil or sulfur derived from a sulfur-based additive. As previously explained with reference to Sato, the amount of sulfur in the composition which is derived from the base oil is critical for providing the observed favorable μ-V characteristics after oxidation. Since Watts does not specifically teach the mass % of sulfur, there would have been no suggestion or motivation based on Watts that such a concentration would have been limited to not more than 0.1 mass % as claimed. There is also no suggestion in Watts that the concentration of sulfur derived from a sulfur-based additive should be limited to 0.01 to 0.15% by mass as claimed.

Watts also does not teach or suggest the amount of borated dispersant which may be included in the composition. Accordingly, there is no basis for the Examiner's conclusion that the claimed B/P mass ratio would inherently occur in the Watts composition.

Finally, Watts teaches that a variety of different additives may be included, such as the corrosion inhibitors taught by Smalheer. Smalheer teaches corrosion inhibitors which include metal dithiophosphates, metal dithiocarbamates, and sulfurized terpenes. Therefore, even the proposed combination of Watts and Smalheer would not teach or suggest the sulfur additives recited in claims 5-9, such as benzothiazoles, trithiophosphites, and polysulfides (claim 6) or thiadiazoles and derivatives thereof (claims 7-9). Accordingly, even the proposed combination of references would not teach or suggest all of the claimed elements. Additionally, there would have been no suggestion based on the proposed combination that the claimed sulfur-based additives would have provided the results exhibited by the presently claimed invention, such as improved μ-V characteristics which prevent scratch noises.

For all of these reasons, reconsideration and withdrawal of the § 103(a) rejection based on Watts in view of Smalheer are respectfully requested.

Rejection Under § 103(a) Based on Bloch in view of Smalheer

The Examiner argues that Bloch teaches lubricating oil compositions, suitable as automatic transmission fluids, which contain a base oil and the reaction product of a phosphating agent and a thioalcohol. Bloch allegedly teaches that the reaction product may be added to the base oil in an amount corresponding to approximately 0.02 to 0.04 mass percent phosphorus in the oil. A boron source may allegedly be added, including borated dispersants, borated amines, borated alcohols, borated esters or alkyl borates, such that a molar ratio of boron to the phosphorus in the reaction product is preferably 0.5 to 2.0. Bloch allegedly teaches that the lubricating oil compositions may contain one or more additives, including corrosion inhibitors and detergents which are typically which the Examiner argues are typically disclosed in Smalheer. Suitable corrosion inhibitors allegedly include metal dithiophosphates and metal

dithiocarbamates, and suitable detergents include calcium-containing detergents. The Examiner argues that Bloch teaches amounts of the various additives in the Table at col. 5, and argues that Bloch teaches that the metal in the detergent component is present in the composition in a metal to phosphorus molar ratio (M/P) of 0.005 to 0.5. The Examiner thus concludes that the transmission compositions of Bloch meet the claimed limitations. The Examiner takes the position that although the mass ratios of phosphorus:calcium:boron:sulfur are not specifically set forth in Bloch, the amounts set forth in compounds containing these elements would result in lubricant compositions which meet the claimed ratio. Applicant respectfully traverses this rejection as follows.

Bloch teaches a lubricating oil composition containing a base oil and the reaction product of a phosphating agent and a thioalcohol. Bloch teaches that such an additive is non-aggressive to silicone-based seals, and is also an effective antiwear agent when used in lubricating oils. However, the invention of Bloch is not designed to provide excellent μ-V characteristics so as to always be maintained in a positive gradient in belt type CVTs to prevent the occurrence of scratch noises even after being used for a long period or time. Since Bloch does not acknowledge the need to maintain excellent μ-V characteristics or a positive gradient thereof, there would have been no motivation to adjust the parameters (such as sulfur content) which are necessary to obtain such results.

Further, Bloch does not teach or suggest the claimed concentrations of sulfur derived from a base oil or sulfur derived from a sulfur-based additive. As previously explained with reference to Sato, the amount of sulfur in the composition which is derived from the base oil is critical for providing the observed favorable μ-V characteristics after oxidation. Since Bloch does not specifically teach the mass % of sulfur, there would have been no suggestion or motivation based on Bloch that such a concentration would have been limited to not more than 0.1 mass % as claimed. There is also no suggestion in Bloch that the concentration of sulfur derived from a sulfur-based additive should be limited to 0.01 to 0.15% by mass as claimed.

Finally, Bloch teaches that a variety of different additives may be included, such as the corrosion inhibitors taught by Smalheer. Smalheer teaches corrosion inhibitors which include

metal dithiophosphates, metal dithiocarbamates, and sulfurized terpenes. Therefore, even the proposed combination of Bloch and Smalheer would not teach or suggest the sulfur additives recited in claims 5-9, such as benzothiazoles, trithiophosphites, and polysulfides (claim 6) or thiadiazoles and derivatives thereof (claims 7-9). Accordingly, even the proposed combination of references would not teach or suggest all of the claimed elements. Additionally, there would have been no suggestion based on the proposed combination that the claimed sulfur-based additives would have provided the results exhibited by the presently claimed invention, such as improved μ-V characteristics which prevent scratch noises.

For all of these reasons, reconsideration and withdrawal of the § 103(a) rejection based on Bloch in view of Smalheer are respectfully requested.

In view of the preceding Amendments and Remarks, it is respectfully submitted that the pending claims are patentably distinct from the prior art of record and in condition for allowance. A Notice of Allowance is respectfully requested.

Respectfully submitted,
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